

## SHORT COMMUNICATIONS

**Spring and fall migration of Peregrine Falcons from Padre Island, Texas.**—Currently, little data exist on the behavior of migrating Peregrine Falcons (*Falco peregrinus*). Enroute ecology of migrant peregrines has been studied at stopover areas such as Asseategue Island, Maryland (Ward and Berry 1972, Ward et al. 1988) and Padre Island, Texas (Enderson 1965, Hunt et al. 1975, Hunt and Ward 1988). Information on migratory behavior of peregrines has been obtained indirectly during short periods of observation and by band recovery data (Enderson 1965, Kuyt 1967, Shor 1970, Henny and Clark 1982, Yates et al. 1988, Schmutz et al. 1991). For example, estimates of speed for migrating raptors have been obtained either by timing migrants over short distances (Broun and Goodwin 1943, Kerlinger 1989) or by calculating the average speed required for migrants to have travelled a given distance, usually during several days and hundreds or thousands of kilometers (e.g., Layne 1982, Foy 1983, Heintzelman 1986).

In this study, we report the pathways and migratory behavior of one fall southbound and one spring northbound migrating Peregrine Falcon, tracked with radiotelemetry after their departures from Padre Island, Texas. Daily flight times, daily distance travelled, and speeds of the spring and fall migrating Peregrine Falcons are presented and compared. Arrival times at, and departure from, night roosts are presented along with observations of flight behavior while on migration.

*Study area and methods.*—Padre Island, Texas, is a barrier island extending approximately 220 km from Corpus Christi southward to the mouth of the Rio Grande. Padre Island as stopover habitat for migrant peregrines has been described previously by Hunt et al. (1975) and Hunt and Ward (1988) and is well known for large concentrations of both fall and spring migrating peregrines (Hunt et al. 1975).

Between 10 April and 26 May 1985, approximately 200 peregrines were captured, banded, and released as part of ongoing banding studies by Kenton Riddle and coworkers. Four females were radio-tagged 21–27 April. Between 14 and 18 October, three females were radio-tagged and released at Padre Island. Captured falcons were banded with U.S. Fish and Wildlife Service aluminum leg bands and fitted with Telonics model 040 transmitters. The radios were attached to the underside of the two central rectrices with linen thread and cyanoacetate glue. Transmitter antennas were attached to the rachis of one of the central rectrices and extended approximately 10 cm beyond the tip of the tail. A Telonics TR-2 receiver and TS-1 scanner were used to track the migrating peregrines. Two side pointing "H" type receiver antennas were attached to the wingstruts of a Cessna 172 aircraft used for tracking the migrating falcons. All radiotagged falcons were monitored between four and eight times per day from the air to determine initiation of migration. Due to the difficulties encountered while tracking migrating raptors, only a single peregrine was monitored each season on its migration flight from Padre Island. The first radio-tagged Peregrine Falcon to leave during each season was monitored. During migration, the peregrines were monitored nearly continuously throughout the day from early morning to the time they roosted in the afternoon. Monitoring was mostly from the air, but on several occasions, the falcons were monitored while the plane was on the ground.

Once in migration, the falcons' daily flight distance (DFD), daily flight time (DFT), and ground speeds were calculated and recorded. Daily flight distance was the total ground distance covered by a falcon from departure roost to evening roost. Daily flight time was the total time the falcon was in flight. Because the falcons sometimes had departed by the time we reached the previous night's roost site, it was necessary to estimate time of departure.

Estimated time of departure (ETD) was extrapolated from the speed and distance of the falcon from the roost when first encountered on its morning flight. Because the falcons were usually intercepted a short distance from the roost site, ETD is believed to be close to actual time of departure. Hereafter, ETD will be used to refer to both estimated and actual time of departure. Estimated time of roosting (ETR) is the time the falcons stopped flying and perched to roost in the afternoon.

Ground speeds (cross country speeds) were estimated in km/h by determining the distance and time elapsed between two location points. The number of precise locations varied daily because of the logistical difficulties of tracking migrating raptors with aircraft. The main problem was finding a place to refuel along the route of the migrating falcon, which on several occasions, caused us to interrupt monitoring and deviate from the falcon's route.

Wind direction and speed during the monitoring of migrating falcons, as well as significant changes such as fronts were noted. Daily wind speeds were classified into one of three categories, light (<10 km/h), moderate (10–19 km/h), and strong (>19 km/h).

Daily flight time, daily distance, and speeds of the two falcons were compared using Mann-Whitney *U*-tests (Conover 1980). It is possible that measurements obtained from a single falcon while on migration may violate the assumption of independence of data points; however, Mann-Whitney *U*-test is recommended by Kenward (1987) for similar analyses.

*Results.*—During the spring migration, four falcons were monitored on Padre Island and moved up to 70 km/day on the island, but they usually returned to a roosting site near that of the night before. During the fall southward migration, the falcons (three) moved less than 10 km from the point of capture, generally in a north-south direction. The movements of spring and fall migrant falcons, while on Padre Island, are for hunting and foraging (Hunt et al. 1975).

The spring migrant, an adult female, was tracked a total of four days from the time she left Padre Island (3 May), covering 2732 km in 46.8 h of effective flight time. The fall migrating peregrine, an immature female, was tracked seven days and flew 1803 km in 37.8 h of effective flight time. On the first day of migration, 3 May, the spring migrant flew northwest and the ETD was 10:30. In the fall, the first peregrine to leave the island flew southwest on 18 October, two days after being radiotagged. The ETD (10:45) for the fall peregrine was similar to the spring migrant's ETD. The first day of migration, the fall migrating peregrine travelled a total of 105 km in 4.8 h, while the spring migrant flew 414 km in 8.5 h.

The direction of flight was constant for the spring migrant but varied for the fall migrating peregrine (Fig. 1). During the spring migration, the falcon maintained a true track of 346°, plus or minus 5°, from Padre Island to the last point of observation in Saskatchewan, approximately 20 km north of the U.S.-Canada border. It crossed the states of Texas, Oklahoma, Colorado, Wyoming, and Montana, parallel to the eastern Rocky Mountains.

The fall migrating peregrine began flying southwest, then continued south and finally east at the Isthmus of Tehuantepec (Fig. 1). The route paralleled the Gulf of Mexico coast through the Mexican states of Tamaulipas and Veracruz to the Isthmus of Tehuantepec. Beyond the Isthmus, the peregrine abandoned the coast and flew directly east along a route that took it through Tabasco and Chiapas in Mexico, over northern Guatemala, and into Belize until it reached the Belize coast. From the Belize coast, it flew eastward into the Caribbean ocean where tracking was terminated.

The spring migrant on several occasions left the roost site before sunrise, while the fall peregrine always commenced flight after sunrise (Table 1). Missing information from the second day was due to our need to clear customs and immigration with the Mexican authorities.

DFDs of the north and south migrating peregrines differed significantly ( $U = 34$ ,  $P <$

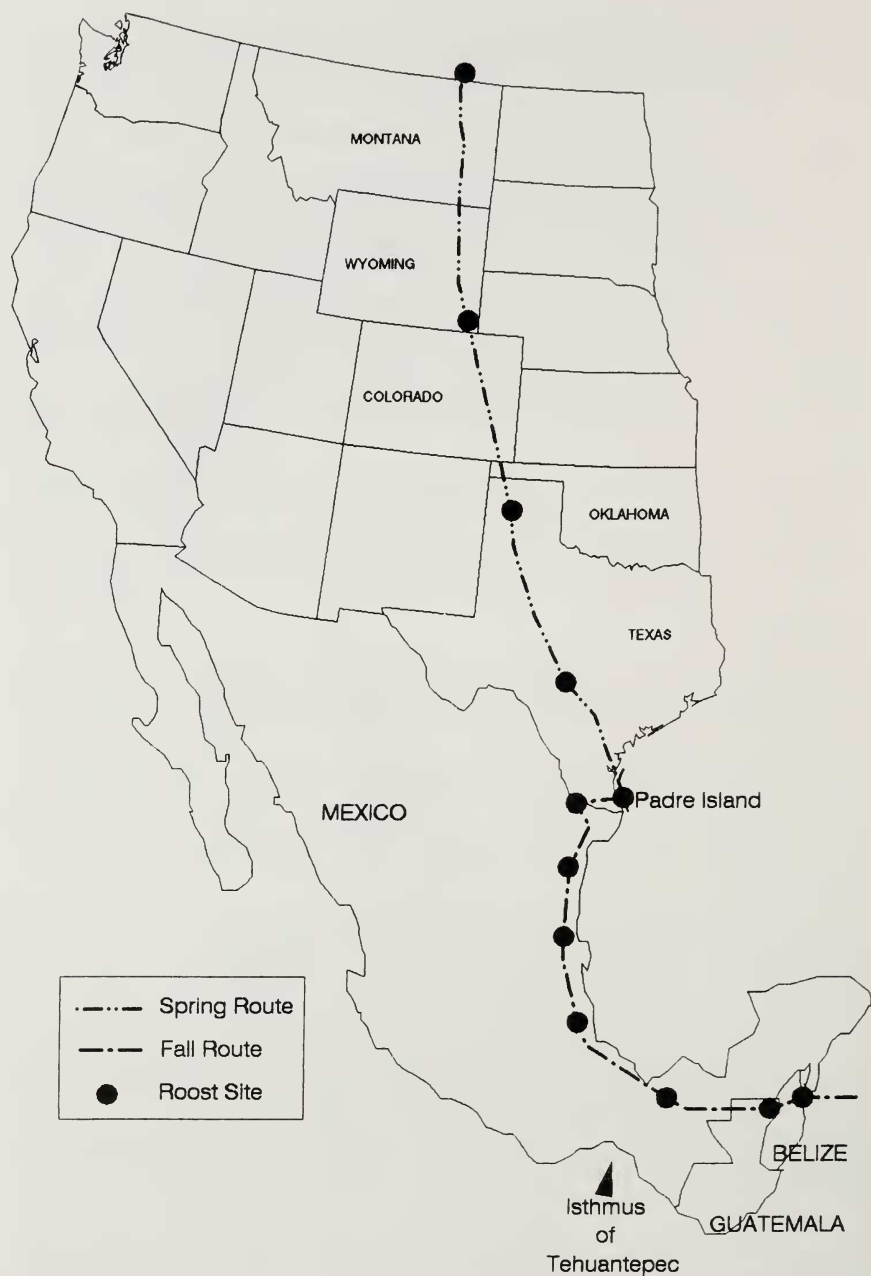


FIG. 1. Migratory routes of one spring and one fall migrating Peregrine Falcon from South Padre Island, Texas.

TABLE 1

ESTIMATED TIME OF DEPARTURE AND ROOSTING TIMES FOR SPRING AND FALL MIGRANT PEREGRINE FALCONS RELATIVE TO SUNRISE AND SUNSET

Day of migration	ETD	Relative to Sunrise	ETR	Relative to sunset
Spring migrant				
1	10:30	—	18:00	+41
2	05:00	+28	18:46	+106
3	04:50	+15	14:00	—
4	05:00	-14	19:28	+18
Fall migrant				
1	10:45	—	—	—
2	—	—	17:06	+31
3	11:15	—	16:10	+82
4	07:00	-53	17:20	+13
5	07:00	-55	17:00	+35
6	07:00	-56	16:05	+96
7	07:30	-86	10:30	—

(+) Minutes before sunrise or sunset.

(-) Minutes after sunrise or sunset.

0.025) (Fig. 2). The north migrating falcon averaged 708 km of DFD (SD = 223.5, range 414–915), while the south migrating peregrine averaged 257 km (SD = 140, range 105–460). Both spring and fall migrants showed a gradual increase in DFD as the migration progressed, with the exception of the seventh day of the fall migrant, when it reached the Belize coast.

The DFTs of the two falcons differed significantly ( $U = 30$ ,  $P = 0.05$ ); the spring migrant flew several hours more each day than the fall migrant (Fig. 2). The spring and fall migrants DFTs averaged 12.02 h (SD = 2.7) and 8.75 h (SD = 2.8), respectively. The DFT of the north bound peregrine showed a trend similar to DFD, increasing sequentially each day. The southward migrating peregrine did not show a similar trend, the DFT remained more constant with exceptions on the third and last day of monitoring. On the last day of migration the falcon reached the Belize coast in only 3.5 h of flying, after which no movements were observed until the following day.

Ground speeds calculated for the two falcons were significantly different ( $U = 258$ ,  $P < 0.001$ ). The spring and fall migrant mean speeds were 58.1 km/h (SD = 13.1, range 38–90,  $N = 17$ ) and 33.6 km/h (SD = 9.6, range 17–52,  $N = 13$ ), respectively. Only small variations in speeds on a given day were observed for the fall migrating peregrine. These variations were usually less than 8 km/h, with one exception. The speeds calculated on the same day for the spring migrant ranged from a minimum of 12 to a maximum of 40 km/h.

Wind velocities during the spring tracking were always moderate and from a southeast direction, with a single exception. On the second day of migration (5 May), a strong cold front moved from the northwest. During the fall tracking wind velocities varied from calm to light and wind direction was varied, being from the southeast (days 1, 2, 3, and 6 of migration), west (day 7), and northeast (days 4 and 5).

*Discussion.*—The north-south movements of radiotagged falcons in this study contrast

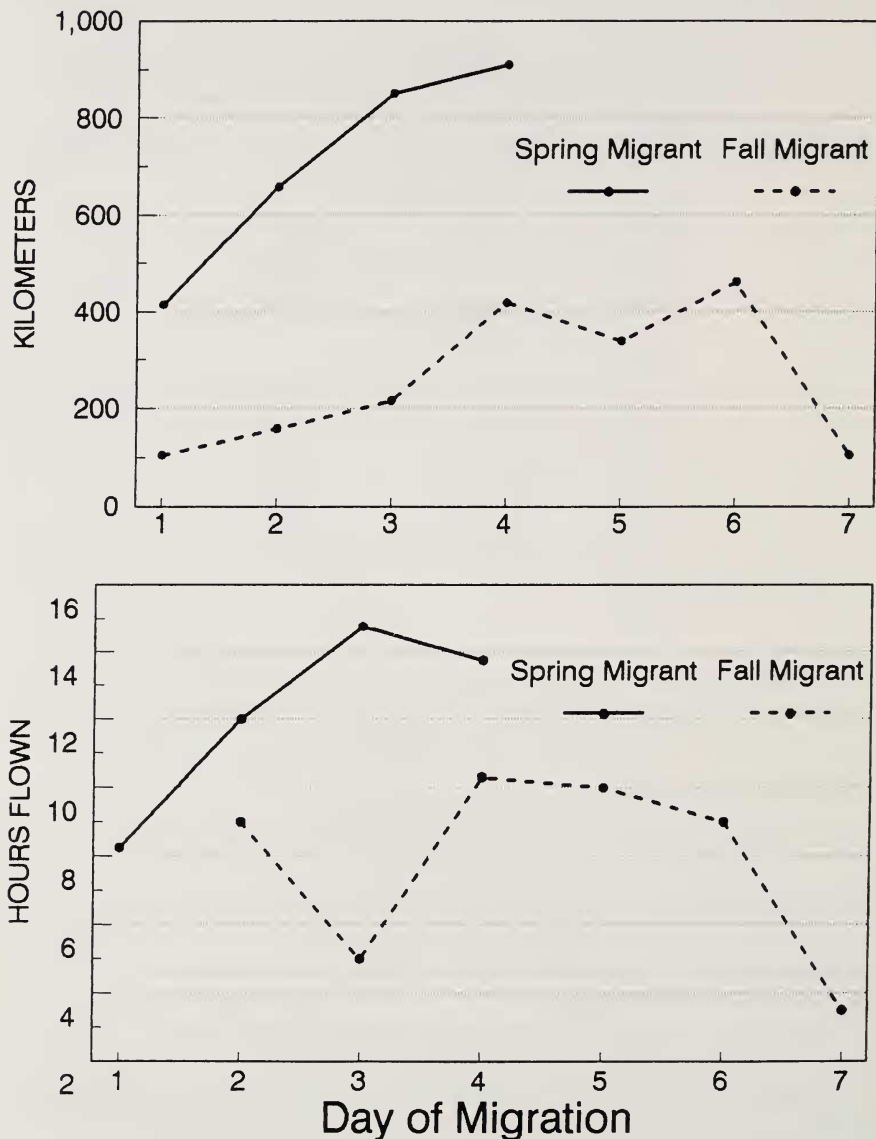


FIG. 2. Daily flight distance and daily flight time of one spring and one fall migrating Peregrine Falcon.

with those observed by Enderson (1965) who found no evidence of north-south movements nor any alternative directional movements of peregrines on Padre Island. The movement of Peregrine Falcons we observed lengthwise along Padre Island, clearly supports the notion (Enderson 1965, Hunt et al. 1975, Hunt and Ward 1988) that this is a very important stopover site for both spring and fall migrating peregrines.

Conflicting accounts exist regarding the type of migratory flight used by Peregrine Falcons. Heintzelman (1986) reports that this species does relatively little thermal soaring, while Cochran (1975) suggests that peregrines use circle (thermal) soaring to a great extent. We believe peregrines used both types of flight while migrating. Using speed to indicate flight type, the speed at which the spring migrant flew in most cases excludes the possibility of thermal soaring. Reported long distance thermal soaring and gliding speeds estimated for raptors do not exceed 50 km/h (Hopkins 1975, Harmata et al. 1985, Smith 1985, Smith et al. 1986, Leshems 1987, others in Kerlinger 1989 pp. 283–286) while this falcon consistently flew at speeds greater than 50 km/h. Only five of 17 speed estimates were less than 50 km/h. It is likely the fall migrant used thermal soaring and gliding more extensively, since its calculated speeds were less than 50 km/h, with a single exception. Thermal formation is not well developed until 3–5 h after sunrise and continues until the sun ceases to heat the earth's surface (Kerlinger 1989). The late departure times and the slow progress observed during at least three mornings by the fall peregrine may indicate that it was waiting for thermal formation to begin flying. However, it is also possible that it may have been hunting.

The great differences observed in speeds and DFD between the two falcons may be due to the age or experience of the falcons, since the spring peregrine was an adult female while the fall migrant was an immature female. While migratory behavior (migratory orientation, feeding, resting) and most aspects of avian migration are believed to be under endogenous or genetic control (Berthold 1990, Gwinner 1990), experience is likely to be important in fine tuning certain aspects of migration. For example, specific migratory pathways and location of stopover areas may be easier to find and use once the route has been travelled previously.

The daily flight distances observed in the two peregrines studied here are greater than previously reported for peregrines. Cochran (1975) reported an average DFD of 111 mile/day (179 km) for a fall migrating peregrine with the longest distance travelled in one day reported as "about 200 miles" (322 km). The average and maximum DFD travelled by the fall migrant in this study are greater than the peregrine tracked by Cochran. The peregrine tracked by Cochran is reported to have used soaring and gliding flight regularly, and hunted as much as twice a day. During fifteen days of migration, the falcon tracked by Cochran (1975) is said to have hunted daily, usually several times, during morning and afternoons. The behavior (gliding flight and hunting), which contrasts with the behavior of the falcon in this study, would greatly reduce the speed and distance a falcon could travel in one day. Hunting by the fall migrant peregrine during this study is not likely to have occurred in the afternoon, since it flew continuously throughout the day and no movements were observed once roosted in the afternoon. At most, the falcon tracked in this study during fall could have hunted on two occasions during the seven days it was monitored after departure from Padre Island.

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**Sex-related local movement in adult Rock Kestrels in the eastern Cape Province, South Africa.**—Long-distance migration in the Rock Kestrel (*Falco tinnunculus rupicolus*) has not been recorded in southern Africa (Moreau 1972), although it is a well-known phenomenon for its European conspecific the Common Kestrel (*F. t. tinnunculus*) (Village 1990). Of 776 Rock Kestrels ringed in southern Africa, nine birds have been recovered, of which only one was found farther than 30 km from where it was ringed (SAFRING, pers. comm.). Partial local movement of Rock Kestrels in South Africa, especially altitudinal movements, have been reported by several authors (Rowan 1964, Tarboton and Allan 1984, Hockey et al. 1989). It remains unclear, however, whether these movements are sex- or age-related, whether the kestrels return to the same area, and how long they are absent from their breeding sites.

*Study area and methods.*—Rock Kestrels are found throughout southern Africa but are most common in the drier mountainous regions. They feed mostly on invertebrates, reptiles, and small mammals and breed on cliffs or in old nests of Pied and Black crows (*Corvus albus* and *C. capensis*, respectively) in trees from August to February (Steyn 1982). I studied 10 territorial pairs of Rock Kestrels in the foothills of the Winterberg Mountain Range (32°10'S, 26°20'E), Tarkastad District, South Africa from April 1990 to June 1991. The average annual rainfall is 426.4 mm with an average daily maximum temperature of 19.0°C in winter and 29.1°C in summer. Kestrels were caught using a bal-chatri trap (Berger and Mueller 1959) and marked individually with color rings. Each territory was searched for kestrels at least once a week. First- and last-sighting dates were used as a measure of arrival and departure dates.

*Results and discussion.*—On average, females left their territories before males, were away longer, and returned after males. All the females, except one, and six of the males left their territories for longer than 25 days (N = 10 pairs). Of the five pairs for which the date of departure was known for both individuals, the female always left before the male (Table 1). In these pairs, the male returned before the female in three instances, with one returning at the same time as the female and one after the female. All the kestrels that left their territories during winter returned to the same territories prior to the breeding season. The male that returned after his female, and one other male, lost their territories to males that occupied the territories during their absence. One of these new males paired with the resident female, and the other paired with a new female.

Prey-strike rates have been shown to follow cyclic vole availability in kestrels in the Netherlands (Rijnsdorp et al. 1981). Prey-strike rates during perch hunting, the predominant hunting method in this study, were used as an indication of food availability to individual kestrels (Table 2). Although prey-strike rate can be highly misleading if there are large differences in prey size, arthropods weighing between 0.1 and 3 g comprised 97.9% (N = 1962 prey items) of the diet (Van Zyl, unpubl. data). Prey-strike rates decreased until birds left the area with an increase on their return.